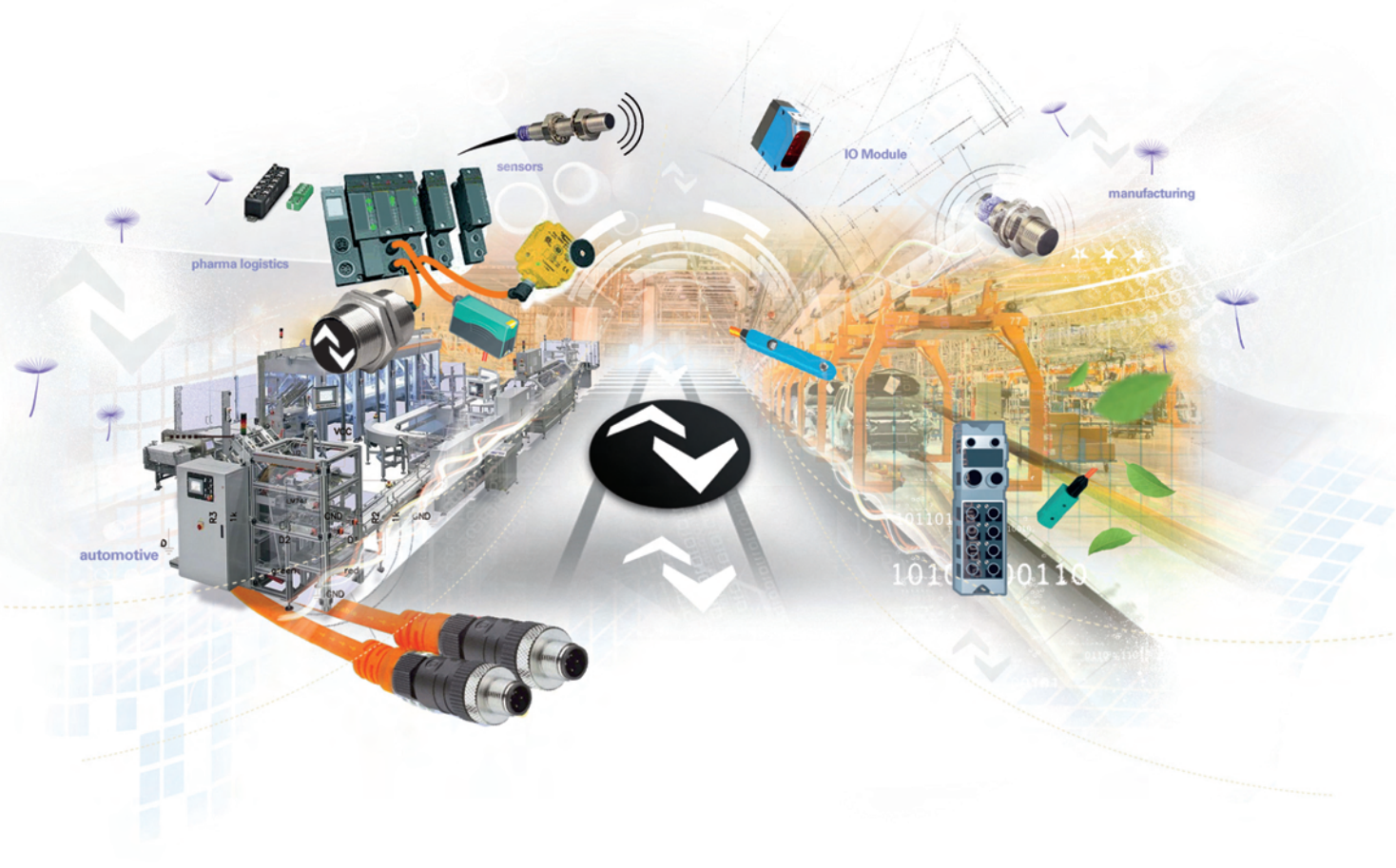
# Single Chip IO-Link: The only all-in-one IO-Link solution.




IO-Link
Breakthrough in communication

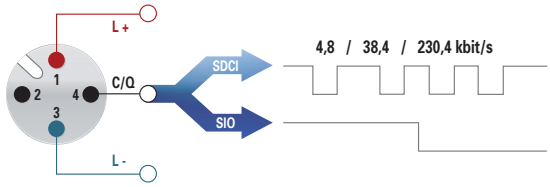
Renesas Electronics
www.renesas.eu

2011.10

# What is IO-Link?

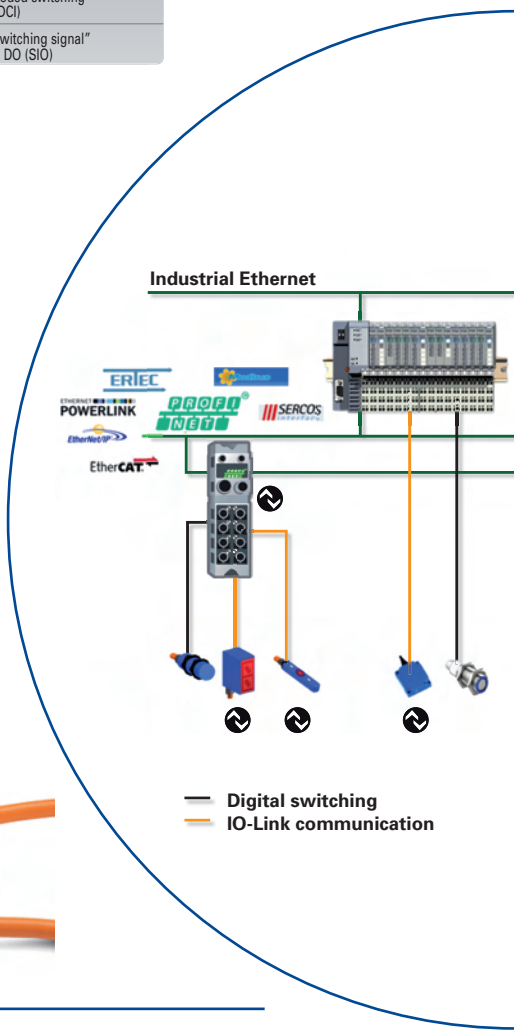
## COMMUNICATION BREAKTRHOUGH STANDARD SENSOR/ ACTUATOR CABLES

IO-Link or SDCI (Single-drop Digital Communication Interface) from the IEC 61131-9 specification, is a point-to-point connection between sensors/actuators and fieldbus level devices. Via a standard 3-wire interface, parameterisation, process and diagnostics data are closing the communication gap in the lowest field level while bringing intelligence down to the smallest sensor and actuator.




| PIN | Signal | Remark |
|---|---|---|
| 1 | L+ | 24V |
| 2 | I/0 | Not connected |
| 3 | L- | 0V |
| 4 | C | "Coded switching" (SDCI) |
| | Q | "Switching signal" DI, DO (SIO) |

| | |
|---|---|
| **Application areas:** | Industrial sensors / actuators, PLC, Remote I/Os |
| **Voltage:** | 0 / 24V |
| **Cable:** | up to. 20 m, 3-wires unshielded |
| **Connectors:** | M5, M8, M12 |
| **Topology:** | point-to-point (master driven) |
| **Data rates:** | 4.8k / 38.4k / 230.4k Bauds |
| **Cycle time:** | 2 ms (typ.), down to < 1 ms possible |




IO-Link significantly reduces the complexity of wiring and installation while extending the capability and functionality of sensors. Multipole-cables and expensive parallel wiring are replaced by industry standardized unshielded 3-wire connection cable.

- Simplify, reduce installation work and cost
- Remote parameterisation and diagnostic
- Backward compatible to conventional Standard IO (SIO)
- Provide smart digital connection for sensors
- Reduce Downtime for maintenance and repair
- Opened standard
- Easy integration into fieldbus systems

# Operation

## CONTINUOUS PARAMETER MONITORING LIVE DIAGNOSIS

IO-Link maximises efficiency by centralizing the retrieval of process data and diagnostic data during operation. With standard tool calling interface applications, fault indications, fault locations in complex machines and plants are handled by the operator, from the control room. New sensors or replacement sensors can get their parameters from the PLC or a data server while the machine is still running.

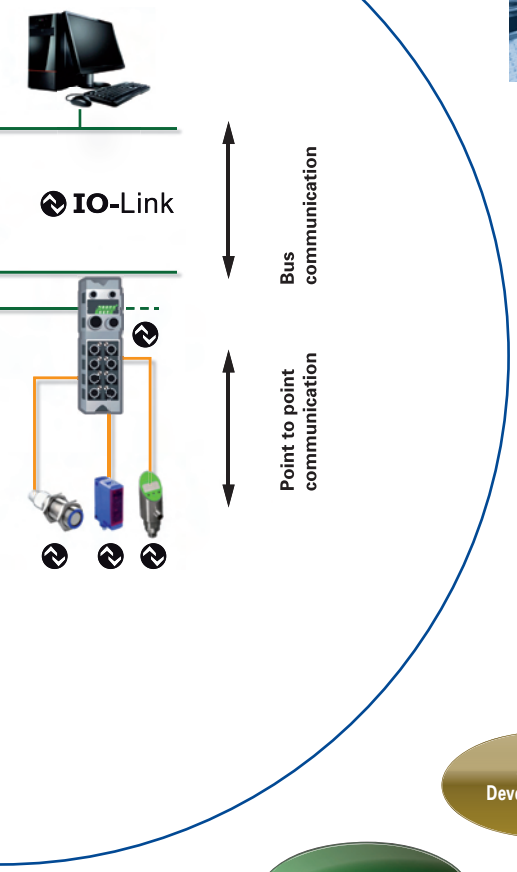
- Point to point connection.
- Quick and easy integration into the established fieldbus systems.
- Full functionality using 3-conductor standard IO cable.
- Expand diagnostics.
- Automate parameter setting.
- Tool assisted parameter setting.
- Minimal hardware and software requirement.

# Service/Commissioning

## IDENTIFICATION TROUBLESHOOTING MAINTENANCE DEVICE REPLACEMENT

**IO-Link capable sensors are identifiable through their Vendor and Device ID**
IO-Link offers parameter settings storage in host automation systems or in a parameter server. The stored parameter can be automatically downloaded to a device within a very short amount of time when the replacement of defective devices is required, or at system start-up. Operation monitoring while the machine is running opens up new possibilities for proactive contamination level detection of devices, greater equipment up-time and better efficiency of production lines.

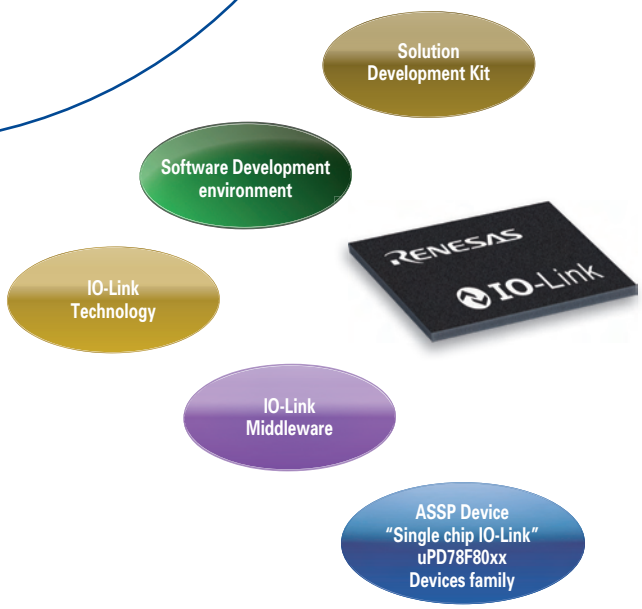
- Reduce machine downtime with preventative maintenance
- Access all diagnostic information directly via device independent operator tooling
- Enable remote device serviceability and diagnostic
- Monitor device availability with communication and operating status
- Automate sensors identification, re-parameterize during operation
- Automate start-up through parameter data storage and duplication
- Eliminate the need for Teach-in or in situ adjustment of sensors




# All-in One IO-Link Solutions

## INNOVATIVE TECHNOLOGY SMART CONCEPT INTEGRATION

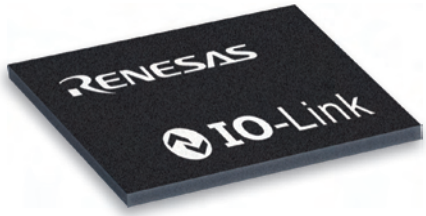
Renesas Electronics is an active member of the IO-Link consortium leading the way on innovation to bring the thriving IO-Link technology in the process automation field. Renesas Electronics with its alliance partners TMG GmbH, and ELMOS Semiconductor AG provides customisable All-in-One solutions packed with added values, to sensors and fieldbus devices manufacturers.




**All-in-One solutions offer:**

- Low cost integrated solutions
- High performance embedded microcontroller
- leading-edge advantages over competition
- Reduced development cost and design cycle
- Innovative range of products
- Proven high quality, reliable technology
- Single technology support channel
- Full compliancy to latest IO-Link specification
- Low Power technology

# IO-Link Device controller




The 78K0R/IO-Link Device controller offers a space-saving solution enabling the development of highly efficient IO-Link industrial sensors. The devices contain a multi-feature packed 16-bit microcontroller for IO-Link stack and sensor applications operation, combined to a Device transceiver (PHY) circuit designed by ELMOS in compliancy with the IO-Link specification V1.1.

### Low cost

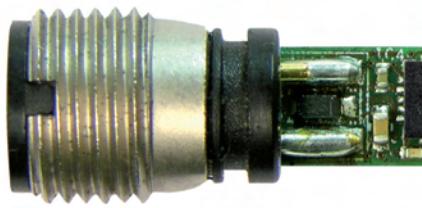
Total system costs can be reduced because of on-chip peripherals such as a voltage detector, oscillator, flash memory, and reset circuit, ADCs, Timers, Serial interfaces.

### Low power

78K0R core consume less current than 16-bit MCUs from other companies at the same operating frequency, helping you realize a low-energy system.

### Highly integrated IC

Integrated IO-Link Transceiver E981.10, backward compatible with conventional SIO connection, featuring a wide input voltage range from 8 V to 36 V, a high driver capability up to 200 mA, integrated wake-up detection and a data transmission speed of up to 230.4 kbit/s.



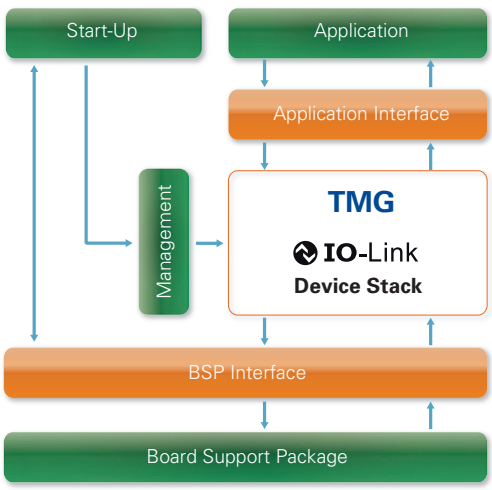
# IO-Link Device Stack Software

## PARTNER OF CHOICE FOR IO-LINK MIDDLEWARE

IO-Link Software environment customized to Renesas Electronics' solutions supporting:

- All IO-Link functionalities according to specification v1.1
- V1.1 devices with backward-compatibility
- Frame Types 0, 1 and 2
- ISDU with 8/16 Bit Index and 8 Bit Subindex
- Events with and without Details
- Modular software design with respect to specification
- Strict separation of protocol stack, application and hardware abstraction
- Consistent exchange of process data via 3 buffers system
- Can run completely as interrupt service without interfering the user-application
- Very fast response-times even with slow-running µC (i.e. 14 µs at 18,432 MHz)
- Application synchronisation with master cycle
- Easy integration: only 8 simple functions have to be adopted
- Sophisticated tracing functionalities
- Codesize down to 2 kBytes
- RAM usage as low as 31 Bytes + pdsize + ISDU-Buffer

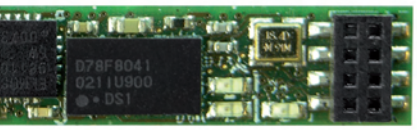
Technologie
Management Gruppe
Technologie und Engineering

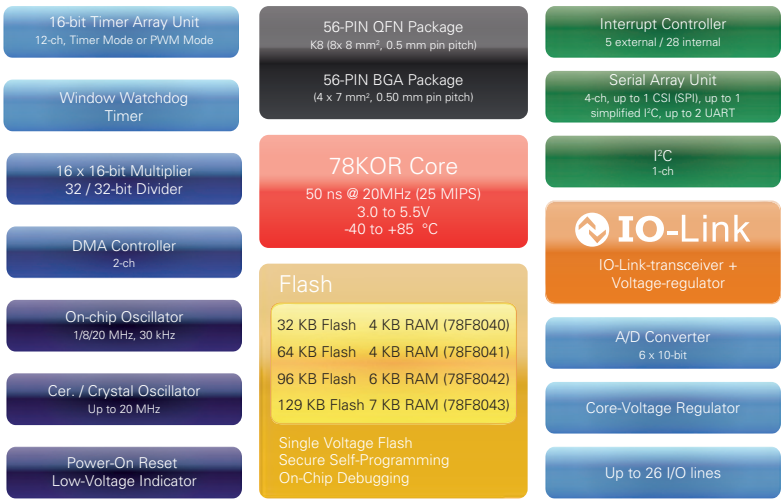


# Features/Product Line-up

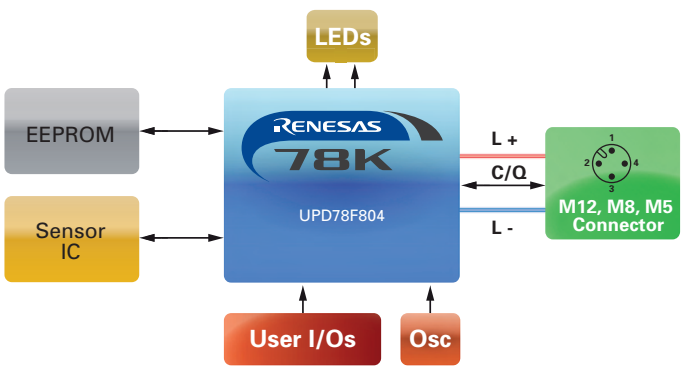
**ALL YOU NEED FOR SENSORS**

- Built-in IO-Link transceiver
  - C/Q reverse polarity protection
  - Integrated 5V voltage regulator
  - Up to 230.4 Kbps selectable baud rate
  - Wakeup detection function
  - 3.3 V / 5 V compatible digital interface
  - Overcurrent detection with shutoff threshold level selection
  - Embedded Safety features
- On-chip feature rich 16-bit Microcontroller
- I/O ports: 26 (N-ch open drain: 2)
- 16-bit timer: 12 channels
- Serial interface: UART(LIN-bus supported)/CSI/ I²C
- 10-bit resolution A/D converters
- Hardware multiplier/divider
- DMA Controllers
- Operating ambient temperature TA = –40 to +85°C




16-bit Timer Array Unit
12-ch, Timer Mode or PWM Mode
Window Watchdog Timer
16 x 16-bit Multiplier 32 / 32-bit Divider
DMA Controller
2-ch
On-chip Oscillator
1/8/20 MHz, 30 kHz
Cer. / Crystal Oscillator
Up to 20 MHz
Power-On Reset Low-Voltage Indicator
56-PIN QFN Package
K8 (8x 8 mm², 0.5 mm pin pitch)
56-PIN BGA Package
(4 x 7 mm², 0.50 mm pin pitch)
78KOR Core
50 ns @ 20MHz (25 MIPS)
3.0 to 5.5V
-40 to +85 °C
Flash
32 KB Flash 4 KB RAM (78F8040)
64 KB Flash 4 KB RAM (78F8041)
96 KB Flash 6 KB RAM (78F8042)
129 KB Flash 7 KB RAM (78F8043)
Single Voltage Flash
Secure Self-Programming
On-Chip Debugging
Interrupt Controller
5 external / 28 internal
Serial Array Unit
4-ch, up to 1 CSI (SPI), up to 1 simplified I²C, up to 2 UART
I²C
1-ch
IO-Link
IO-Link-transceiver + Voltage-regulator
A/D Converter
6 x 10-bit
Core-Voltage Regulator
Up to 26 I/O lines

# Target Applications

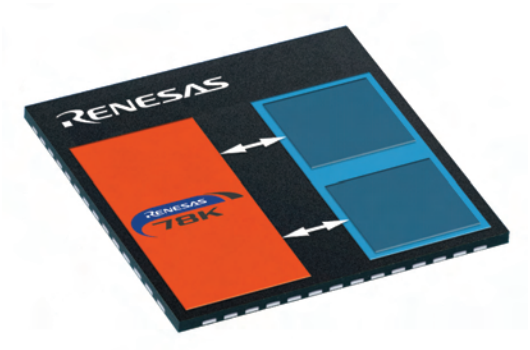



The 78K0R/IO-Link Device family scalability in terms of package (8x8 mm QFN and 4x7 mm BGA), memory and peripherals provides the most versatile development platform for current and future generation of sensors. From miniature to larger size sensors, simple to complex applications, the high performance embedded 78K0R core, with a diversity of on-chip peripherals, allows designers to flexibly react on changing requirements during development.

The design of this microcontroller guarantees its integration at different levels of an application's system architecture. The 78K0R/IO-Link Device controller is usable as first micro, second micro, or communication controller in sensor applications.

# IO-Link Master controller

## INNOVATIVE TECHNOLOGY SMART INTEGRATION CONCEPT




The 78K0R/IO-Link Master controller offer a fully integrated platform for Master applications. The uPD78F86x devices family incorporates two independent IO-Link Master channels compliant to the latest IO-Link specification V1.1 integrated with a high performance feature rich and low power 16-bit microcontroller.

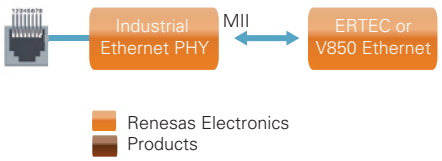
### Advantages

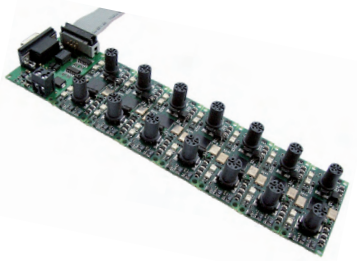
- Dual independent fully featured IO-Link Master ports
- High speed serial interfaces to External host controller Interface
- Designed for scalable solutions.
- Low power consumption
- Powerful controller
- Easy and simple integration interface requiring only 4 pins
- Firmware upgradable from Host controller
- On-chip data flash for parameter storage features

# Sum Telegram Protocol

## HIGH THROUGHPUT LOW LATENCY

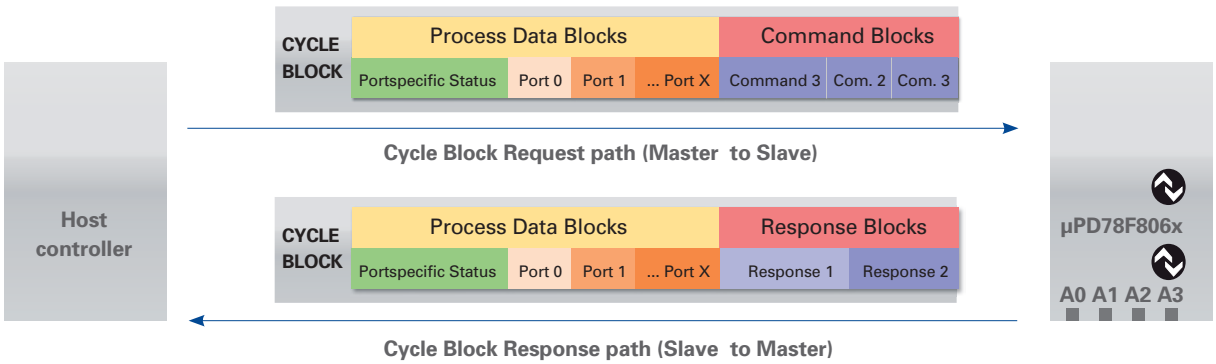
Take advantage of the scalability and flexibility provided by the 78K0R/IO-Link Master controller, a high throughput, low latency inter-microcontroller bus nicknamed “Sum Telegram Protocol” is developed and supported by Renesas Electronics and its partner TMG GmbH.



### Supported features

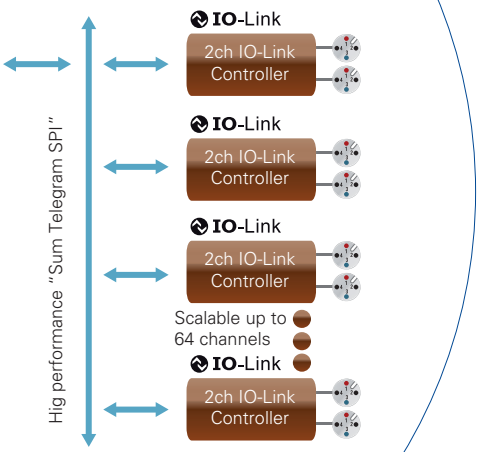
- Bidirectional transport of cyclic and acyclic data
- High data-rates synchronous exchange via SPI interface
- Protocol completely and specifically optimized for synchronous transfers
- Single request/response path between SPI Master and Slave
- Optimized Telegram structure for Protocol bus including (Op-code, offset windows, status, command, and process blocks)
- Host-controller commissioning based on the IO-Link port-configuration.



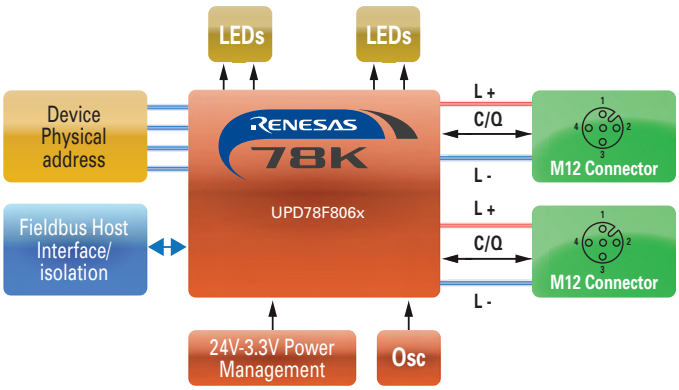
# Features

## SCALABLE FLEXIBLE EFFICIENT

- Built-in 2 channels ELMOS IO-Link Master transceivers
  - IO-Link supply switch supporting external PMOS transistors
  - Wake-up generation support
  - Digital inputs configurable for IO-Link or IEC61131-2 compatible interface
  - SPI interface for configuration, programming and diagnostic functions
  - Overcurrent & short-circuit protection at output stages with configurable thresholds
  - Over temperature protection
- On-chip feature rich 16-bit Microcontroller
- Hardware multiplier/divider
- DMA Controllers
- On-chip data flash for parameter storage features
- CAN controller
- Power supply voltage:
  - VDDH = 8.0 to 36.0 V
  - VDD = 2.7 to 3.45 V
- Operating ambient temperature: TA = –40 to +85°C
- Operating frequency: 2 to 24 MHz



# Target Applications



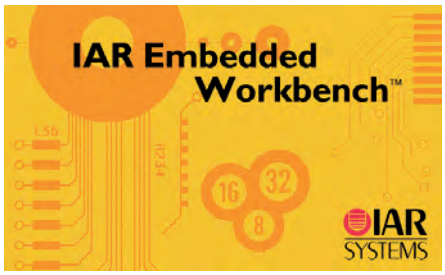

The 78K0R/IO-Link Master products bring adoption of the IO-Link standard to the world of automation for an array of applications ranging from Remote I/O, PLCs, to smart integrated industrials drives. With two embedded channels and a high-speed host interface, IO-Link ports integration and scalability has never been made easier. The 78K0R/IO-Link Master controller is the most flexible platform available. Conjointly the most cost effective solution on the market.
The controllers boast sufficient user IOs to build fully featured IO-Link masters. The collection of embedded processing blocks means that the use of external components is reduced to a minimum, where space saving is crucial.

# Integrated Development Environment

### IAR Embedded Workbench

IAR Systems provides a range of development tools for embedded systems: integrated development environments (IDE) with C/C++ compilers and debuggers, development kits, hardware debug probes and state machine design tools.

- Highly optimizing IAR C/C++ Compiler
- IAR Assembler
- Versatile IAR XLINK Linker and IAR XAR Library Builder
- Powerful editor, project manager and command line build utility
- IAR C-SPY® Debugger, a state-of-the-art high-level language debugger



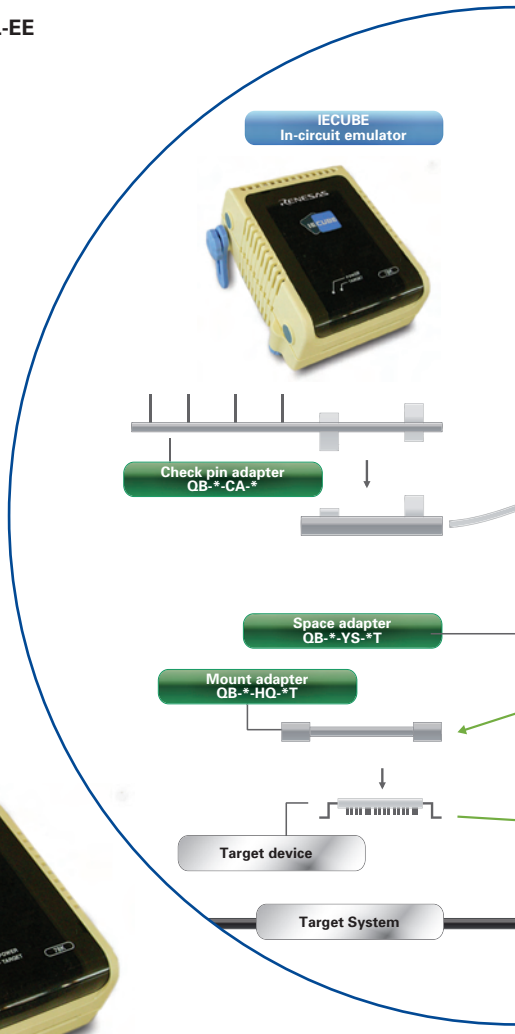

**Model No: EW78K-FULL-EE**

### Applilet Device Driver Configurator

Applilet is a software tool that generates device driver code to initialize and use on-chip peripherals.

- Easy to use graphical user interface
- Improved code quality
- Fasten the development process
- Automatic code generation for IAR Embedded Workbench and Greenhills Multi
- Free download from Renesas Toolweb

**Model No:**
**APx-78K0xxx-EE**




# Emulators

### IECUBE In-circuit Emulator

The QB-78K0RKX3C in-circuit emulator allows efficient hardware and software emulation/debugging for systems development based upon 78K0R/Kx3-C and 78K0R/Kx3-L microcontrollers.
Products (socket bundle package) specialized for the IO-Link microcontrollers package are available (emulation probe, exchange adapter, target connector, etc. provided).

**Model No: QB-78K0RKX3C-ZZZ-EE**

- Frequency, voltage & memory capacity same as target device
- USB 2.0 interface
- Break functions
- Event Break
- Trace functions
- Real time RAM monitor function
- Time measurement
- Debugger, programmer (MINICUBE2) provided as standard

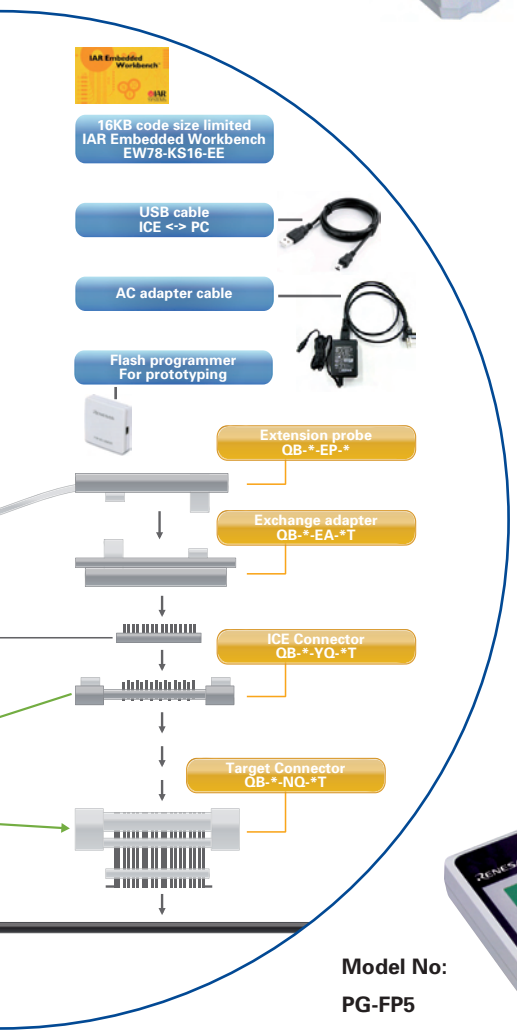
# Debuggers

**Model No:**
**R0E000010KCE00**

## E1 Debugger

E1 provides all the basic debugging functions while serving as a flash programmer at the same time.

- Highly affordable on-chip debugging emulator for Renesas's mainstream MCUs.
- Affordable yet powerful debugging device
- On-board programmer.
- Can be used as an on-board programming tool after the debugging, enabling smooth evaluation of the MCU.
- Optimally suited for evaluating analogue functions such as A/D and D/A properties.
- Both the serial and JTAG connections are supported.
- Simple connection via connector mounted on the user's system
- Environmentally friendly material.



**Model No:**
**QB-MINI2**

## MINICUBE2

With a debugging function that can detect problems in programming, and a programming function that can write programs to the microcontroller, this single unit has you covered from debugging to mass production.

- On-chip Debugging and Flash Memory Programming
- Low price
- Compatible with 8-, 16- and 32-bit (78K0, 78K0S, 179K, 78K0R, V850)
- Supports flash memory products with single power supply
- Small form, light weight, and you can attach a strap, just 48x48x12.4 mm

**Model No:**
**PG-FP5**

## PG-FP5

The PG-FP5 is a tool for erasing, programming, and verifying programs on Renesas MCUs with on-chip flash memory, either installed in a system or mounted on a program adapter.

- Enhanced features for programming on production lines, including remote interface & buzzers
- Support for self diagnostics, security settings, and other stability/security enhancing features
- Fast downloads using USB 2.0
- Wealth of optional products, including programming adapters supporting All Flash
- Full support for our Flash microcontrollers
- Target Device: V850,RX Family, RL78 Family, 78K0R, 78K0, 78K0S

# IO-Link Master Starter Kit

**Target Applications:**

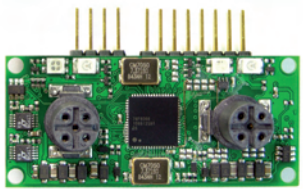
> IO-Link Gateway, PLC, Remote I/O
> Demonstration/Evaluation of uPD7808x MCUs
  – Up to 16 IO-Link Master channels designs

**Hardware Content:**

> Header board (host controller, Gateway)
> Master Module (Dual IO-Link channels board)

**Key features:**

> 78K0R/IO-Link microcontroller
  – µPD78F8066 in 9x9 QFN package
> USB connection to host PC
> CAN interface
> Communication interface for external Host controller
> On-chip Debugging/programming interface
> Power supply interface
> Dual M12 5-poles connectors
  – x2 IO-Link port
  – x2 Digital I/Os IEC 61131-2 Type 1
> LED Status and communication Indicators



**Model No:**
**Y78K0RIOLINKMADM**

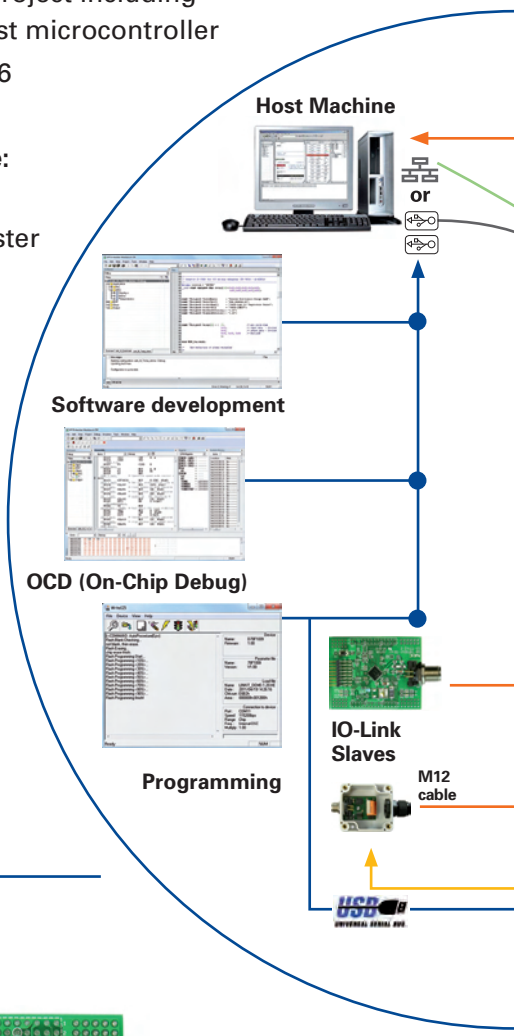
**Software package content:**

> Renesas Device Tool*
> TMG IO-Link Master stack,
> IO-Link specification 1.1 compliant
> Host library interface source code
> Running demo project including BSP for V850 host microcontroller
> IAR EW78K_KS16

**Model No:**
**Y78K0RIOLINKMRSK**

**Optional Hardware:**
**Add-on module**

> Dual IO-Link Master channels board
> Available for design requiring more than 2 IO-Link channels
> 78K0R/IO-Link microcontroller
> µPD78F8069 in 9x9 QFN package




# Target boards

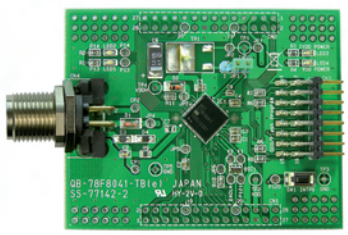
**Target applications:**

> IO-Link Sensors
> Demonstration/Evaluation of uPD7804x MCUs

**Key features:**

> 78K0R/IO-Link microcontroller
  – µPD78F8041(µPD78F8041K8).in 8x8 QFN package
> Access available to All microcontroller's pins
> Boost Transistor (complements with use of internal voltage regulator)
> External Interrupt button

**Model No:**
**QB-78F8041-TB**



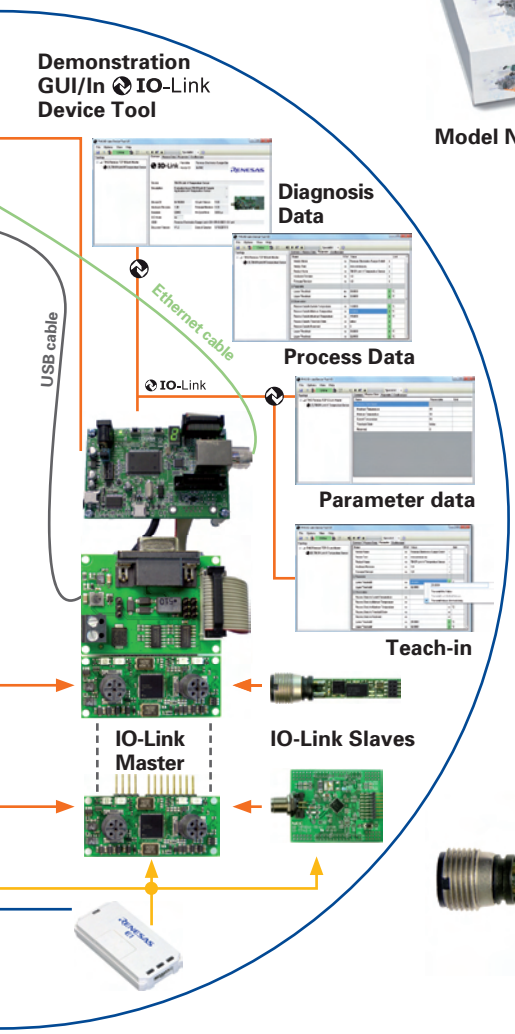
> Power LED indicators
> QB-MINI2 (MINICUBE2) programming/debugging interface
> M12 connector for easy interface to industrial IO-link masters
> Prototyping area

# IO-Link Device Starter Kit

**Target Applications:**

> IO-Link Sensors
> Demonstration/Evaluation of uPD7804x MCUs
> Pre-programmed with temperature sensor demo

**Model No: Y78K0RIOLINKDRSK**



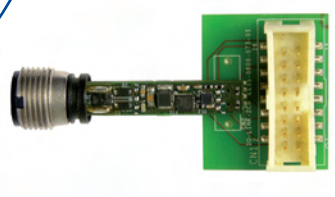

**Key Features:**

> 78K0R/IO-Link microcontroller
  – µPD78F8042(µPD78F8042K8).in 8x8 QFN package
> IO-Link communication specification v1.1 Compliant design
> On-board Sensing modules
> Expansion board interface
> Operational status Indicator
> On-chip debugging/Flash programming interface
> Power supply alternatives
  – Industrial 24V via M12 A-coded port
  – 5V or 3.3V compatible digital interface
> IO-Link Interface:
  – M12 4-Poles male A-coded connector, physics 2-3W
  – Data storage support enabled

**CD-ROM Software package content:**

> User Manual
> IO-Link specification 1.1 compliant TMG IO-Link Slave Stack library
> IODD v1.1 Device description file sample
> Running demo project
> IAR EW78K_KS16

# Dual Channel Demo board



**Model No: IOL_2CH**

**Target Applications:**

> Small form factor sensors
> IO-Link 1.1 evaluation
> 4 wires sensor reference design
> 78K0R/IO-Link Microcontroller Demonstration

**On board features:**

> 78K0R/IO-Link microcontroller
  – µPD78F8041(µPD78F8041K8).in 4x7 BGA package
> IO-Link communication specification v1.1 compliant design

> IO-Link Interface:
  – M12 4-Poles male A-coded connector, physics 2-3W
> Data storage support enabled
> Configurable second channel
  – Digital I/O on Pin 2 compatible IEC 61131-2 Type 1
> Communication status LED indicators
> On-chip debugging/ Flash Programming interface
  – QB-MINI2 (MINICUBE2) interface
> User accessible interface: Serial Interface, ADC input

**Software package content:**

> Sample software for evaluation based on Link-It temperature demo sample
> IAR EW78K_KS16
> IO-Link specification 1.1 compliant TMG IO-Link Slave Stack library
> IODD v1.1 Device description sample.

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